THE FLORA OF CUTTYHUNK ISLAND, MASSACHUSETTS:

WITH AN ANALYSIS OF VEGETATIONAL CHANGES OVER THE PAST HALF CENTURY

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Cuttyhunk Island lies at 41° 25′ N. latitude, 70° 56′ W. longitude at the westernmost end of the Elizabeth Islands. These islands extend south-west from Woods Hole, Massachusetts, in two parallel ridges and include seven main islands as follows: Nonamessett, Uncatena, Naushon, Pasque, Nashawena, and Cuttyhunk, with Penikese located one mile north of Cuttyhunk (see Figure 1.). The geological origin of the Elizabeth Islands has been investigated by Woodworth and Wigglesworth (1934) and by Chamberlain (1964). According to these studies, Cuttyhunk and the other Elizabeth Islands were formed by a recessional moraine during the Wisconsin Glacial Stage of the Pleistocene. They are believed to date from approximately 14,000 years before present (Flint, 1971).

The flora of Cuttyhunk Island was first studied as part of the larger flora of the Elizabeth Islands (Fogg, 1930). No additional study of the Cuttyhnk flora had been done until the present investigation. The goal of this investigation has been to compile a second flora of the vascular plants of Cuttyhunk and then to interpret the floristic and vegetational changes that have occurred there over the past half century based on a comparison of the two floras and in light of the theoretical considerations of island biogeography.

TOPOGRAPHY

Cuttyhunk Island is shaped like a one-clawed lobster approximately two and one-half miles long and three-quarters of a mile across at its widest point. It consists of a central portion with two smaller necks of land at the eastern end (see Figure 2.). The island has two large salt water lagoons, Cuttyhunk Pond and Gosnold Pond. A small islet, Gosnold Islet, is located within the latter. Both ponds are subject to severe barrier beach erosion.

The main portion of Cuttyhunk Island is dominated by a central morainal hill that reaches a maximum elevation of approximately 42

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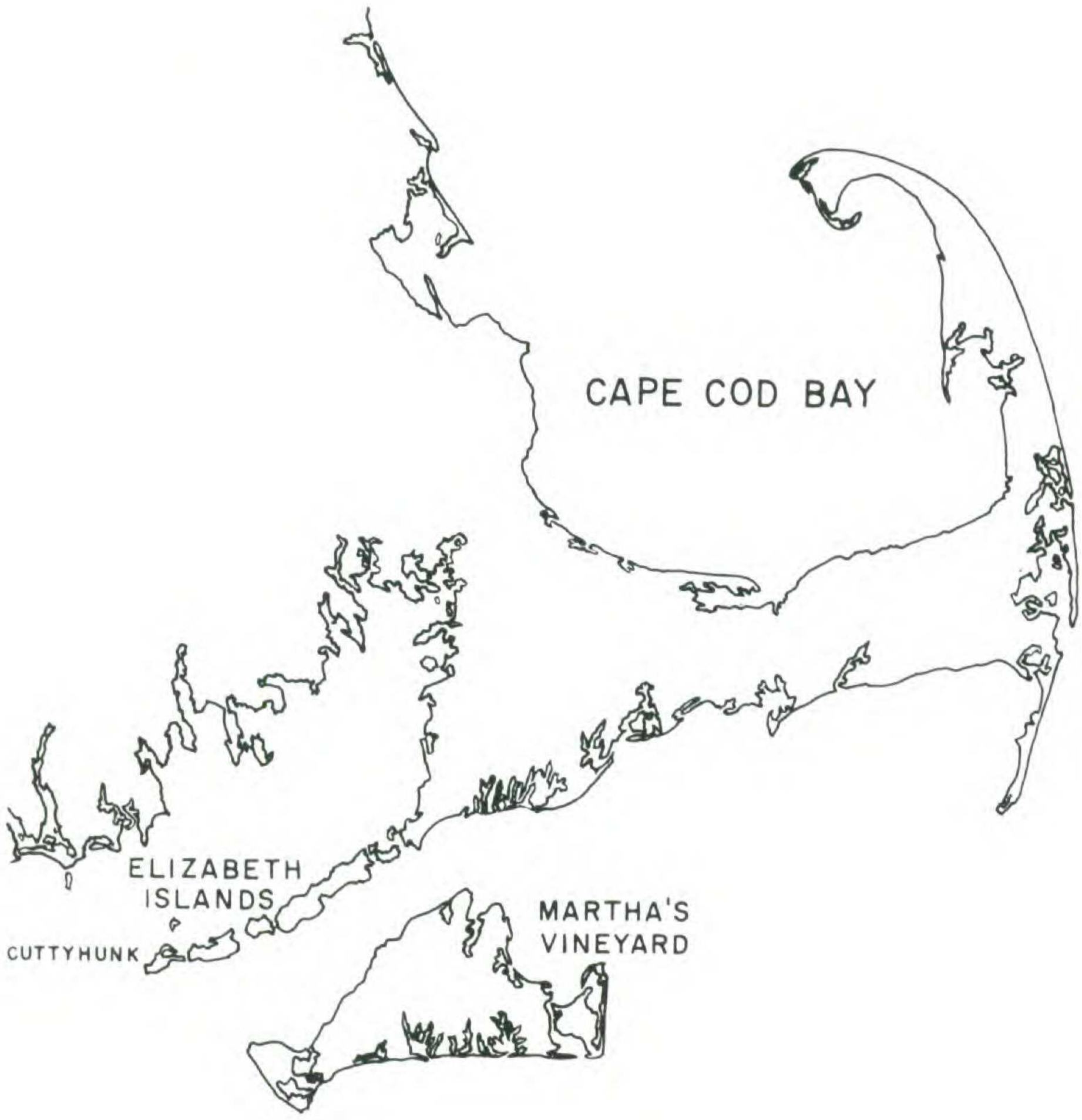

Figure 1. **Cape Cod and the Elizabeth Islands**

meters above sea level on Lookout Hill (Woodworth & Wigglesworth, 1934). The entire island exhibits a topography of morainic knobs and ridges. Cliffs are found along the north and south shores and were probably located on the west shore as well until recently.

Severe storms and hurricanes of the present century have caused considerable loss of land at the southwestern end of the island and along Canapitsit Neck. In 1938, a 12-foot tidal wave and 90 mile per hour winds destroyed an extensive area along South Beach. In 1944, a hurricane with winds up to 100 miles per hour struck the island, severely eroding the narrow barrier beach that partially encloses

Gosnold Pond so that by 1972 the returning tides had clearly divided this barrier beach in one location along the north shore permitting the invasion of salt water. Sheep Pond, the smaller pond adjacent to Gosnold Pond, contained fresh water until 1956 when the narrow sand bar separating it from Gosnold Pond was eroded away by a storm.

Cuttyhunk has a number of smaller ponds maintained by the water table 6 to 32 feet above sea level (Strahler, 1966). While most of these ponds are seasonal and occur in morainal depressions, four are apparently man-made ponds. Several small brackish ponds are located just behind the north shore of Copicut Neck. Salt marshes are situated in the lee of barrier beaches and near salt water ponds.

That Cuttyhunk Island was formerly connected to the neighboring island of Nashawena by a narrow sandy isthmus can be surmised from a description left by the historian and chronicler, M. John Brereton, who stated in 1602 that the circumference of "Elizabeth's Isle" was "sixteen English miles at the least in compass; for it containeth many pieces or necks of land, which differ nothing from several islands . . ." (Brereton, 1602, p. 88.). The earliest known chart of Cape Cod and the New England islands prepared in 1720 likewise depicted Cuttyhunk and Nashawena as one large island joined by a thin barrier beach (Woodworth & Wigglesworth, 1964).

Cuttyhunk itself was also undoubtedly larger in 1602 when Brereton made his description; he had described Gosnold Pond as being about three miles in circumference, a size far too great for that of the present day pond. The pond's boundaries may have lain farther north in 1602. Since this earlier description erosion has driven the barrier beach inwards.

Historical Record and Land Use

The recorded history of Cuttyhunk Island began on May 25, 1602, when the English explorer, Bartholomew Gosnold, decided to found a settlement on the western end of Cuttyhunk on Gosnold Islet.

Gosnold's chronicler and historian, M. John Brereton, left an account of the mature forest species present on Cuttyhunk at the time of colonization in 1602:

> "This island is full of high timbered oaks, their leaves thrice so broad as ours; cedars, straight and tall; beech, elm, holly, walnut trees in abundance, the fruit as big as ours, as appeared by those

> we found under the trees, which had lain all the year ungathered; hasle-nut trees, cherry trees . . .; sassafras trees, great plenty all the island over, a tree of great price and profit; also, divers other fruit trees, some of them with strange barks of an orange color, in feeling soft and smooth like Velvet: in the thickest parts of these woods, you may see a furlong or more round about." (Brereton, 1602, p. 88–89)

A second chronicler in Gosnold's party, Gabriel Archer, described Cuttyhunk as follows:

> "It is overgrown with wood and rubbish, viz. oaks, ashes, beech, walnut, witch-hazel, sassafras and cedars, with divers other of unknown names. The rubbish is wild pease, young sassafras, cherry-trees, vines, eglantines, gooseberry bushes, hawthorn, honeysuckles, with others of like quantity. The herbs and roots are strawberries, raspberries, ground-nuts, alexander, surrin, tansy, etc. without count." (Archer, 1602, p. 77)

Apparently the settlers ate berries and herbs or salads (Gookin & Barbour, 1963), and at one point, a food shortage forced Gosnold's company into eating "Alexander, Sorrell pottage, and ground nuts". Gosnold's men deforested the island, carrying the wood back to England, and established the precedent for future land use.

It is apparent that land use has been directly responsible for the general vegetational aspect of Cuttyhunk for over a hundred years. Fogg (1930) observed during his collection trips that Cuttyhunk was largely open hillsides and meadows with the aspect of bleak grassy downs, "exposed to the full blast of winds from the Atlantic". He also stated that "within the memory of no living inhabitant have there been trees on Cuttyhunk or Penikese, except the few which have been planted by the hand of man".

At that time most of the land was under cultivation, or used as pasturage for grazing cows and sheep. Several of the 11 grass species collected by Fogg were species of high forage quality. Sheep had been raised on Cuttyhunk ever since the Cuttyhunk Club imported several hundred head sometime after 1869. Before the importation of sheep, early farmers grazed cows on uncultivated land. A 1942 Geological Survey map of Cuttyhunk depicts the island as entirely denuded except for patches probably representing swampy lowlands along the southwest bottom half of the island and in one area on Copicut Neck.

According to an account of Gookin and Barbour (1963), the western part of the island was given over to the grazing sheep just

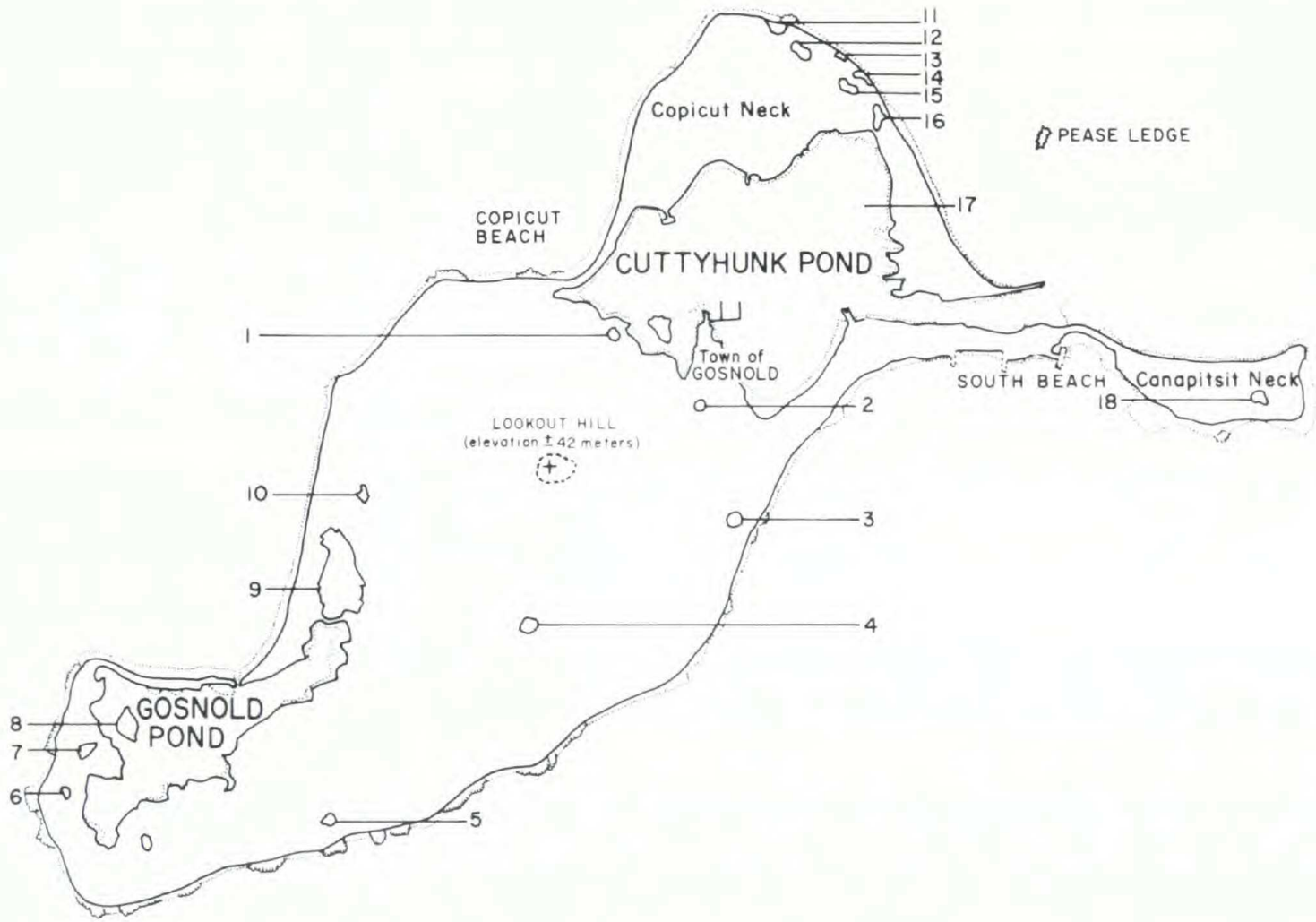

Figure 2. **Cuttyhunk Island. 1.** Pickerelweed Pond **2.** Tilton's Pond **3.** Town Water Supply Reservoir **4.** Dump Pond **5.** Spaulding's Pond **6.** Fresh Water Pond 1 **7.** Fresh Water Pond 2 **8.** Gosnold Pond (also known as Westend Pond) **9.** Sheep Pond (also known as Wash Pond) **10.** *Decodon-Osmunda-Typha* Pond **11.** Cattail Pond **12.** *Hibiscus* Pond **13.** Brackish Pond 1 **14.** Brackish Pond 2 **15.** Toad Pond **16.** Salt Marsh Pond **17.** Cuttyhunk Pond **18.** Canapitsit Marsh

about twenty-five to thirty years ago. They described the vegetational character of Cuttyhunk during the 1950's in this manner:

> "There is a startling contrast between the Cuttyhunk that Bartholomew Gosnold knew and named Elizabeth's Isle and the island as it appears today. The whole of the western part of the island is now a treeless plain, recently given over to the grazing of sheep, bred in experiments to obtain finer grades of wool. Before that this plain was under cultivation, even including the little islet in the lake..." (Gookin & Barbour, 1963, p. 142)

The western and central parts of Cuttyhunk Island are currently protected from further development and agricultural practices as a conservation area, so that about two-thirds of the central section of the island has now reached a shrub stage in relatively uninterrupted succession. Cuttyhunk's current conservation area also provides a suitable habitat for large populations of white-tail deer (*Odocoileus virginianus*) and cottontail rabbits (*Sylvilagus transitionalis*).

In 1974, there were approximately 21 families or about 52 permanent residents on Cuttyhunk. The total population in the summer is well over 500 people as a result of tourism. In the past the chief professions of the island residents were piloting, cod fishing, lobstering, and farming (Haskell, 1950). Today's residents no longer farm or raise livestock, and instead summer tourism has become an important source of income.

MATERIALS AND METHODS

The 1923 flora of Cuttyhunk Island (Fogg, 1930) consisted of 134 species of which 21 were non-native. Fogg included species collected earlier by the following collectors: F.W. Pennell (1911), S.N.F. Sanford (1917), W.R. Taylor (1919), and E.W. Hervey (no date). Although omitted in the 1923 flora, these species are listed in Fogg (1930).

No similar botanical or ecological investigation had been conducted until the present study. During a series of 12 field trips in the summer and fall of 1974, specimens of 266 species were collected in identifiable condition. Collection trips were made on the following dates: June 28; July 7, 10, 14, 17, 24–26; August 4, 13–15, 20, 24–26; September 8–10, and October 10.

VEGETATION

Beach Community

Cuttyhunk is surrounded by several categories of beaches: cobble, sand, and a mixture of cobble, gravel, and sand. True beach vegetation occurs only on the sandy beaches of the two necks at the eastern end of Cuttyhunk. Here the beach vegetation is distributed in fairly discrete belts beginning at the drift line and proceeding inland to the furthest limits of the storm tides. Plants established in these belts include: *Atriplex patula, Cakile edentula, Chenopodium album, Erechtites hieracifolia, Solidago sempervirens, Suaeda maritima, S. linearis,* and *Zostera marina.* On exposed sandy area, the dominant species are *Ammophila breviligulata, Solidago sempervirens, Lathyrus japonicus, Myrica pensylvanica,* and *Rosa rugosa. Phragmites australis* and *Artemisia stelleriana* are also locally abundant in dense clumps.

Salt Marsh Community

The salt marsh community on Cuttyhunk consists of mostly shallow areas on Cuttyhunk Pond near the Gosnold Marina, on the northern shores of Gosnold and Sheep Ponds, and a third near a salt pond on Copicut Neck (see Figure 2.). Specimens collected from these sites are listed in Table 1. All species throughout marked with an asterisk were also present in the 1923 flora (Fogg, 1930).

Several other salt marsh species, *Plantago oliganthos, Salicornia bigelovii,* and *S. europaea*, were restricted to a small tidal pond (Pond 16) on the cobble north shore of Copicut Neck. A sizable brackish pond in the same area (Pond 11) was enclosed by a thick marginal zone of *Typha latifolia.* Other species typical of damp shores, salt pond borders, and brackish marshes include *Galium tinctorium, Lindernia anagallidea, Ptiliminium capillaceum, Ranunculus cymbalaria,* and *Teucrium canadense.*

Table 1. Abundant species of salt marshes. Species also included in the 1923 flora (Fogg, 1930) are noted by an asterisk.

Distichlis spicata	*Sagina procumbens*
*Eleocharis smallii**	*Salicornia virginica**
Juncus canadensis	*Spartina alterniflora*
*J. gerardi**	*S. patens*
Limonium nashii	*Spergularia rubra**

Fresh Water Marsh Community

This community consists of many species also found in both the pond and swamp-shrub communities. Those species significantly abundant in fresh water marsh areas are listed in Table 2.

Table 2. Abundant species of fresh water marshes.

Decodon verticillatus	*Osmunda cinnamomea**
Dryopteris noveboracensis	*Phragmites australis*
*D. thelypteris**	*Scirpus cyperinus**
Iris versicolor	*Scutellaria epilobifolia**
*Juncus acuminatus**	*Teucrium canadense*
*Lycopus uniflorus**	*Typha latifolia*
Onoclea sensibilis	*Woodwardia areolata**

Pond Edge Community

There are between 15 and 17 small ponds ranging from salt to fresh water. Most of the smaller ponds on Cuttyhunk are seasonal: all but one of the fresh water ponds of natural origin were nearly dry by mid-summer.

The vegetation of the fresh water ponds appeared to be distributed along a gradual gradient of water depth, forming concentric zones of vegetation. The surfaces of all ponds were free from floating macrophytes. In the centers of those ponds that retained a substantial depth of water, *Myriophyllum humile* and *Prosperpinaca palustris* were often collected. Floating-leaved anchored aquatics were likewise restricted to those ponds with an adequate supply of water (Ponds 1,2). Common plants of this zone included *Nymphaea odorata* and *Nuphar variegatum*, with both *Pontederia cordata* and *Hydrocotyle umbellata* more restricted in their total distribution.

Most of the Cuttyhunk ponds are no deeper than one meter, so that the wetland vegetation around ponds often consisted entirely of the

Table 3. Emergent anchored species of the pond community.

Carex crinita	*J. pelocarpus*
C. comosa	*J. effusus**
*C. filiculmis**	*Phragmites australis*
C. odoratus	*Scirpus americanus*
C. diandrus	*S. cyperinus**
Eleocharis obtusa	*Sparganium americanum*
*Juncus acuminatus**	*S. eurycarpum*

anchored emergents listed in Table 3. Most of the shallow ponds supported abrupt transition zones around their perimeters. Characteristic species collected here are listed in Table 4. Many of the moist pond bottoms were covered by a green layer of the liverwort, *Riccia*, and later by dense mats of vascular plants as the water evaporated. *Ludwigia palustris* formed colonies on the bottoms of most ponds. In other drier areas, pond bottoms have been colonized by grasses including *Echinochloa crusgalli, Glyceria obtusa,* and *Panicum dichotomiflorum,* all invaders since the earlier flora. The border of one Cuttyhunk pond (Pond 10) has developed into a fen and supports an anchored marginal mat of *Decodon verticillatus, Osmunda cinnamomea,* and *Typha latifolia.* Several additional species have also established themselves near this area since the earlier flora. These are *Drosera rotundifolia, Equisetum arvense,* and *Lycopodium inundatum.*

Table 4. Characteristic species of the wetland ecotones.

Apios americana	*L. uniflorus**
Cyperus odoratus	*Onoclea sensibilis*
Decodon verticillatus	*Phragmites australis*
Dryopteris thelypteris	*Polygonum persicaria*
Glechoma hederacea	*P. punctatum*
Hibiscus moscheutos	*P. puritanorum*
Hypericum boreale	*P. scandens*
H. mutilum	*Prunella vulgaris*
H. virginicum	*Rumex maritimus*
Iris versicolor	*Scutellaria epilobifolia**
*Lycopus americanus**	*Teucrium canadense*

Grassland Community

Extensive grasslands are most prominent in the central section of the island. In all grassland areas, the dominant species is *Panicum virgatum* in association with *Agropyron repens, Agrostis stolonifera, A. tenuis, Anthoxanthum odoratum, Dactylis glomerata, Holcus lanatus,* and *Phleum pratense.* Also abundant in the grasslands throughout are *Juncus bulbosus, J. greenei,* and *J. tenuis.* About 15 less common grass species were also collected. Some of these species were previously cultivated for pasturage. A fairly common inhabitant of the grassland community, *Achillea millefolium,* has certainly increased since the earlier flora; Fogg noted the uncommon distribution of this species on Cuttyhunk in 1923.

The floristic composition of the grasslands community has reached a mixed herbaceous perennial stage. The most abundant grass, *Panicum virgatum,* was collected by Fogg from all the islands except Cuttyhunk. Another common grass, *Dactylis glomerata,* was collected previously only from Penikese. Both *Agrostis* species were collected throughout the grasslands in 1974; these species are also recent colonists of the Elizabeth Islands in general. *Anthoxanthum odoratum* and *Juncus greenei* are equally abundant and widely distributed. *J. greenei* was not collected by Fogg; however, he remarked its abundance on all the islands, and it may have been present on Cuttyhunk as well.

Andropogon scoparius, a characteristic grass of secondary succession in old-fields, was rather uncommon in the summer of 1974. Several *Panicum* species including *P. clandestinum, P. commutatum, P. oligosanthes* were collected mostly from unimproved road edges. Other species new to the grasslands are *Elymus virginicus, Eragrostis spectabilis, Festuca rubra, Poa annua, P. compressa,* and *P. pratensis.*

Table 5. Species collected from the edges of unimproved roads.

Anagallis arvensis	*O. stricta*
Hieracium florentinum	*Ranunculus bulbosus*
*Hypericum perforatum**	*Rudbeckia hirta**
Hypochoeris radicata	*Solidago nemoralis*
Juncus greenei	*S. rugosa**
*J. tenuis**	*S. tenuifolia*
Leontodon autumnale	*Spergularia rubra**
Oxalis europaea	*Taraxacum officinale*

Shrub Community

The shrub community now dominates almost all uninhabited sections of Cuttyhunk. In the central section of the island, the development and growth of the shrub community has resulted in the contraction of the open grasslands, giving the area a mosaic appearance.

Myrica pensylvanica has given the shrub community a special composition. This species has also increased in coastal communities, invaded the road edges, and become common in disturbed areas around Cuttyhunk Pond. *Myrica pensylvanica* is well known for its ability to survive the dessicating effects of windborn salt spray as well as mechanical damage from wind alone. It has been found that *M.*

pensylvanica has the special ability to fix atmospheric nitrogen, which substantially contributes to its success as a pioneer species in coastal succession (Morris et al, 1974).

Other shrub species have similarly increased in abundance, including *Clethra alnifolia* and *Viburnum dentatum.* Both *Rhus typhina* and R. *copallina* are now as abundant and widespread as *Myrica pensylvanica.* Neither of these two species were collected by Fogg. He noted the occurrence of *Rhus typhina* on Nashawena and Penikese as occasional in sheltered hollows and hillsides with *R. copallina* occupying open slopes and moist depressions (1930). *Ilex laevigata, I. verticillata, Robinia hispida, Rosa virginiana, Salix discolor,* and *Vaccinium corymbosum* are more limited in distribution.

In other areas around Gosnold, *Populus alba* has become a nuisance in lawns and roadsides. Attempts to eradicate this introduced species have proved unsuccessful. Three other cultigens, *Berberis thunbergii, Ligustrum vulgare,* and *Syringa vulgaris* have likewise escaped into the shrub community along roadsides in Gosnold and elsewhere.

The shrub community, like the grasslands, also supports many prostrate and ascending species. Few if any open fields and meadows are free from the low growth of *Rubus* subgenus *Eubatus* plants, including such representatives as *R. arenicola, R. flagellaris,* and *R. jaysmithii.* Other shrubescent vegetation collected in 1974 not reported in the earlier flora were *Lonicera japonica, Parthenocissus quinquefolia, Toxicodendron radicans, Rubus occidentalis, Smilax rotundifolia,* and *Vitis labrusca.*

Swamp-Shrub Community

The swamp-shrub community is most widespread on the western end of the main island in lowland regions. Swampy areas are also present in wet hollows on the northeastern side of Copicut Neck. The herb stratum of many swampy areas is dominated by *Osmunda cinnamomea.* Several ferns are new to the swamp community, including *Dryopteris noveboracensis, Osmunda regalis,* and *Onoclea sensibliis.* Other common herbs include *Iris versicolor* and *Scutellaria epilobifolia.* Other shrubs and small trees which have recently invaded swampy lowland regions are *Cephalanthus occidentalis, Decodon verticillatus, Ilex laevigata, I. verticillata, Prunus serotina, Pyrus floribunda, Salix discolor* and *Spirea tomentosa.*

Weed Community

Cuttyhunk supports a sizeable ruderal community of both indigenous and alien species occurring in roadsides, lawns, and abandoned fields in Gosnold, coastal waste areas near human activity, and disturbed inland areas. Some of the more common ruderals are listed in Tables 5-7.

Table 6. Species collected from the edges of improved roads in Gosnold.

*Achillea millefolium**	*Digitaria sanguinalis*
Aster ericoides	*Erigeron canadensis*
A. novi-belgii	*Linaria canadensis**
Asclepias syriaca	*L. vulgaris*
Ambrosia artemisiifolia	*Melilotus alba*
A. psilostachya var. *coronopifolia*	*M. officianlis*
Arctium minus	*Oxalis stricta*
Cichorium intybus	*Saponaria officinalis*
Daucus carota	*Trifolium pratense*
	Vitis labrusca

Table 7. Species collected from coastal waste areas.

Achillea millefolium	*Plantago lanceolata*
Ambrosia artemisiifolia	*P. major*
*Cerastium vulgatum**	*Polygonum aviculare*
Cichorium intybus	*Rumex acetosella*
Lepidium virginicum	*R. crispus*

Two other disturbed habitats were remarked on Cuttyhunk during the present flora, each possessing a distinct assemblage of weedy species. Early in the summer of 1974, the dominant species at the town dump were *Chrysanthemum leucanthemum* and *Verbascum thapsus*. These were replaced as dominants as the season progressed by *Arctium minus*, *Anthemis cotula*, *Erechtites hieracifolia*, and *Matricaria matricarioides*. In late summer and early fall, *Solidago tenuifolia* was abundant around the dump's border. A second major disturbed area, the sandpit, supported several species not observed elsewhere: *Hypericum gentianoides*, *H. canadense*, and *Trichostema dichotomum* var. *linearis*. In addition, a single representative of *Datura stramonium* was observed in a disturbed area adjacent to a residential building. No specimen was collected. This latter plant is apparently rare on Cuttyhunk but was quite common in 1973 on neighboring Penikese (Lauermann & Burk, 1976).

CHANGES IN THE VEGETATION

The beach vegetation on Cuttyhunk has changed very little in the last 50 years. Most of the species collected by Fogg were still present in 1974, although both *Salsola kali* and *Arenaria peploides* were uncommon in both numbers and distribution. One major difference was the widespread occurrence of *Ammophila breviligulata* which Fogg had collected from Penikese but failed to note on Cuttyhunk, although it may have been present at that time as well.

Several other beach plants have invaded the drift zone including *Chenopodium album, Erechtites hieracifolia, Euphorbia polygonifolia, Polygonum maritimum,* and *Suaeda maritima.* A small colony of about twenty individual plants of *Glaucium flavum* has become established at the eastern end of the island. Fogg observed this species only on Naushon. Several hundred plants of *G. flavum* were observed on Penikese in 1973 (Lauermann & Burk, 1976). Other invaders since the earlier flora are *Erigeron canadensis, E. pusillus, E. strigosus, Teucrium canadense,* and *Polygonum aviculare.*

One of the more notable changes in the salt marsh vegetation since the 1923 collection has been the apparent loss of *Puccinellia paupercula* from the mud flats of Cuttyhunk Pond, possibly the result of frequent dredging of this shallow tidal lagoon. *Boehmeria cylindrica* also appears to be extinct around the borders of salt marshes and brackish ponds.

Salt marshes have recently been created around Sheep Pond. In 1956, and again in 1972, the sandy barrier separating Sheep Pond from Gosnold Pond was destroyed by severe storms, permitting the intrusion of salt water. An extensive salt marsh has developed at the eastern end. A third change in the salt marsh vegetation has been the invasion of *Distichlis spicata, Spartina alterniflora,* and *S. patens*— all dominant species of the salt marsh community (Teal & Teal, 1969).

Spartina pectinata, on the other hand, was not observed on Cuttyhunk during this investigation and appears to be displaced by the other *Spartina* species. Other colonists of the salt marsh community include *Eleocharis smallii, Hibiscus moscheutos, Limonium nashii, Sagina procumbens,* and *Salicornia bigelovii.*

The major changes in the pond vegetation over the past 50 years can best be explained by successional processes and changes in the water table. Once the seasonal ponds have dried, their bottoms are

rapidly invaded by species that prefer drier substrates. In two dramatic cases of pond succession where conditions have become unsuitable for usual pond vegetation, the pond bottoms have been rapidly invaded. One former pond on Copicut Neck (Pond 12) now supports a dense stand of *Hibiscus moscheutos* while another West End pond (Pond 6) supports a dense stand of *Phragmites australis.*

Successional development has also resulted in the loss of many species from open wet lowlands and swamps. These species are listed in Table 8. The open moist hollows of the earlier collection have been closed by a shrub overstory in most areas.

Table 8. Species lost from wetland habitats since 1923.

Acorus calamus	*Habenaria clavellata*
Bartonia virginica	*H. lacera*
Carex howei	*Mentha crispa*
C. limosa	*Polygala cruciata*
Elatine minima	*Rhexia virginica*
Eriophorum tenellum	*Rhynchospora alba*
E. virginicum	*Scirpus validus*
Vaccinium macrocarpon	

The irrupting whitetail deer (*Odocoileus virginianus*) population may also be responsible in part for the sizeable reduction in the number of *Carex* species collected from pond margins. In 1974, the estimated size of the deer population had reached 150 individuals. In most pond areas, the *Carex* inflorescences were observed to have been cropped, presumably by these deer, by August.

Changes in pond salinity may account for many losses of wetland species. A boreal sedge, *Eleocharis uniglumis,* had been at the southernmost limit of its range around Sheep Pond during the earlier collection but was not observed in 1974. *Menyanthes trifoliata* and *Vallisneria americana* have also been lost from the Sheep Pond area. The change in salinity of Gosnold Pond may be responsible for other losses. *Cladium mariscoides* has been lost from the sandy beaches bordering both these ponds.

In general, Fogg collected approximately 46 species from moist fresh water habitats between 1923 and 1928; 24 of these species are now extinct on Cuttyhunk. However, the number of invasions exceeds the number of extinctions of species typical of pond borders and wetland regions since no less than 32 species have invaded these areas since the earlier flora.

There has been a considerable increase in the number of grass species in the grassland community. Fogg listed nine grass species characteristic of this community in the earlier flora. Only two of these have been lost: *Calamagrostis canadensis* and *Paspalum ciliatifolium*. This latter species was formerly abundant in distribution. Overall the grasslands exhibit an increased diversity; at least 21 grass species have invaded this community since the earlier collection.

The decrease in abundance of several non-grass species in the grassland community is indicative of the change in the vegetational structure of Cuttyhunk resulting from old field succession. Fogg noted *Hypoxis hirsuta* as "abundant on open, sandy slopes and knolls at the west end of Cuttyhunk." *Hypoxis hirsuta* is now uncommon even in open fields. *Ranunculus acris* and *Sisyrinchium atlanticum* exhibit the same pattern change in abundance while *S. graminoides* had disappeared altogether.

Several other species have also become extinct as a result of successional development. *Asplenium felix-femina, Dennstaedtia punctilobula, Linum striatum* and *Viola fimbriatula* were previously common on the open hillsides. Several *Carex* species have likewise disappeared. Fogg collected *Carex debilis* from "moist hollow on the hillsides." These moist hollows are now filled in with shrub vegetation. *Carex longii* is no longer "frequent in open grassland" nor are *C. silicea* and *C. swanii* found on dry hillsides (Fogg, 1930). Up until about 10 to 20 years ago, Cuttyhunk residents burned the grasslands over most of the island in order to encourage the growth of nutritionally valuable forage species. A type of grazing succession ensued which partially determined the floristic content of the remaining grasslands today.

So far succession following fire in the grasslands seems to have reached a point in which the invasion of the shrub community into the mature grasslands is well advanced. Thus, the vegetational changes since the earlier botanical work of Fogg are predominantly related to the gradual cessation of burning, cultivating, and pasturing the grasslands. The most marked difference observable from comparison of old photographs and descriptions with the present vegetation is in the extent of the shrub community in relation to the grasslands. Most of this change in the grasslands probably occurred within the first fifteen years after the cessation of these agricultural practices. This can be deduced in part from a photograph taken in the early 1960's which documents the presence of a dense shrub layer

already covering the west end and Gosnold Islet (Dorothy Merrill, pers. comm.). It is widely believed that the shrub stage usually dominates the vegetational aspect of old fields for about 16 to 20 years after abandonment.

The western half of the island has undergone considerable successional change over the last two decades and has achieved a mature shrub stage. It is assumed that a similar change occurred on Copicut Neck since the vegetational character of this peninsula today is also dominated by the shrub layer with very few fields remaining open.

The number of woody species in the shrub stratum has tripled since the earlier flora. Fogg collected eight shrub species representing approximately 6% of the total flora. By 1974, this number had increased to about 40 woody species so that these shrub species now represent approximately 15% of the total species number.

A remarkable number of species in the weed community have invaded Cuttyhunk since the 1923 collection. Some of these species are new to the Elizabeth Islands in general, such as *Oxalis corniculata* and *O. stricta.* A specimen of *Ambrosia psilostachya* DC. var. *coronopifolia* (T.&G.) Farw. in fruiting condition was collected from a disturbed area near the Gosnold Marina. This species, although previously reported for Martha's Vineyard and Nantucket, is still of rare and local occurrence in New England. Other species formerly rare or restricted in distribution to the inner islands have since spread to the outermost island. This is particularly true for weedy species. For instance, *Phytolcca americana* was rare on Pasque in 1923 but is now common on both Cuttyhunk and Penikese (Lauermann & Burk, 1976).

Table 9. Number of native and non-native species in each flora and the ratio of non-native/native species.

Collection	Total Species	Native Species	Non-native Species	Ratio non-native/nat
1923	134	113	21	.19
1974	263	182	81	.44

One of the major changes in the flora of Cuttyhunk has been the addition of many alien species to the weed community itself. The number of non-native species on Cuttyhunk has markedly increased as is shown by the data in Tables 9 and 10. Fogg collected 21 non-

native species out of a total of 134 species. These 21 alien species represent 15.67% of the total flora. Out of a total of 263 species collected in 1974, 81 species were non-native. These 81 species constitute 30.80% of the total flora. As Table 9 indicates, the number of non-native species in the flora of Cuttyhunk has increased about four-fold since the 1923 collection. The ratio of non-native/native species has likewise increased from .19 to .44 over the past 50 years.

Table 10. Percent of native and non-native species in each flora.

Collection	Percent native species	Percent non-native species
1923	84.33%	15.67%
1974	69.20%	30.80%

Table 11. Total number of species, genera, and families for each flora

Collection	Species	Genera	Families
1923	134	99	42
1974	263	166	61

DISCUSSION AND BIOGEOGRAPHIC CONSIDERATIONS

It has long been thought that the Elizabeth Islands would never reach a naturally reforested state. One visitor to Cuttyhunk in 1903 expressed a common sentiment:

> "We can hardly believe that the island was ever wooded, for the only trees there are two rows of silver poplars that form a shady lane..." (Watson, 1903, p. 9)

Fogg (1930) described the original climax vegetation of the Elizabeth Islands as stands of *Fagus grandifolia* interspersed with other climax forest species including *Acer rubrum, Carya alba, Cornus florida, Hamamelis virginiana, Nyssa sylvatica, Ostrya virginiana, Prunus serotina, Quercus alba, Q. velutina,* and *Sassafras albidum.*

He blamed the lack of natural reforestation of these islands on the stressful climatic conditions of the New England coast, particularly the high velocity winds, which he believed restricted the vegetation to a scrub growth stage. He assumed that a post-Pleistocene land bridge had enabled more successful migrations of forest species in past

geologic time. Fogg also felt that because of Cuttyhunk's final position in the island chain this island's central grasslands suffered the most of all the Elizabeth Islands from the Atlantic winds. Furthermore, he dismissed the browsing of sheep as having limited importance in maintaining the disturbed condition of these islands. In agreement with Fogg, Woodworth and Wigglesworth (1934) stated that "trees cannot survive except in the lee of some protective barrier of lower, hardier bushes, or of hills." More recently Gookin and Barbour (1963, p. 142) have stated that "strong, salt-laden winds sweep over the place [Cuttyhunk] now [1950's] and keep it barren except for grass."

The southwest winds that blow over Cuttyhunk certainly do have a harsh effect on the vegetation. Yet it appears that the role of wind alone in maintaining a deforested state on Cuttyhunk has been over-emphasized while the importance of land usage and other agricultural practices have been overlooked. In fact, Oosting and Billings (1942) have shown that wind-born salt spray is the chief factor controlling coastal vegetation and not the high velocity wind in itself. Several aspects of the salt spray community described by Boyce (1954) for Cape Cod are also evident on Cuttyhunk.

Only 25–35 years at the most have elapsed in most areas on Cuttyhunk Island since the cessation of agricultural practices. In this comparatively short time, Cuttyhunk seems to have already reached an advanced shrub stage. Moreover, the island apparently has not equilibrated with respect to either total species number or successional stage. At its present point in successional development, Cuttyhunk's subclimax vegetation continues to sustain large populations of whitetail deer (*Odocoileus virginianus*) and cottontail rabbits (*Sylvilagus transitionalis*). The feeding preferences of both these species and the size of their populations will certainly influence the course of sere development and the character of plant communities on Cuttyhunk in the future if left unmanaged.

As of 1974, the deer population had increased unchecked by natural predators or hunters to an estimated 150 deer in an area of approximately two square miles. The rabbit population is also sizeable and unchecked by predators. The deer have created a management problem throughout the island. They have been accused of cropping the crowns of newly planted trees and of pilfering vegetables from local gardens. Unless some management practice is implemented, it seems inevitable that their browsing of the natural

woody vegetation as well as their trampling of the shrub community will retard and possibly reverse any successional progress in the near future. Several residents have begun to plant trees enclosed in protective fences to encourage the development of a forested island.

It seems likely that artificial reforestation of Cuttyhunk will be necessary if present ecological conditions and lack of adequate propagule source areas do indeed make it difficult for climax tree species to colonize the island. The problem of reforestation remains to be solved by time and vegetational recovery. Few tree species were found on Cuttyhunk in the summer of 1974. On Copicut Neck, abandoned orchards of *Pyrus malus* have taken on an open woodland aspect. *Acer rubrum* and *Salix babylonica* had been planted around Gosnold and have successfully naturalized in disturbed areas and roadsides. Scattered specimens of *Prunus serotina* and *Pyrus floribunda* were also observed. Isolated *Sassafras* seedlings have also been reported.

For the first time since 1602 parts of Cuttyhunk Island are advancing towards a naturally reforested state relatively unperturbed by agricultural practices. Yet it is more than likely that the species composition of such a forest stage will be substantially different from the original vegetation described by Fogg.

Furthermore, the marked invasion of ruderal vegetation reflects the increase in disturbance on this island occasioned by civilization and increased human activity. Cuttyhunk apparently offered fewer opportunities for the invasion of alien species during Fogg's investigation. Undoubtedly there were fewer houses at the eastern end of the island and only unimproved roads in the 1920's at the time when Fogg did his collecting. In contrast, waste places and roads paved for automobile traffic were fairly common at the eastern end of the island in 1974.

Table 12. Total flora at each collection period with invasions, extinctions, and persisting species since 1923

Collection	Number of Species
1923	134
extinctions since 1923	62
1974	
persisting since 1923	72
invasions since 1923	192
Total	264

The mode of transportation to the island has changed considerably since Fogg's visits as well. Modern day Cuttyhunk is serviced by two ferries and two sea-planes, all agents for seed dispersal. Three of these passenger vehicles leave from metropolitan New Bedford daily. Although cars cannot be transported on the ferries, at least a dozen motor vehicles are already present on Cuttyhunk. The vehicles further transport tramp species to various parts of the island. Other alien species have apparently been introduced by fructivorous birds and sea fowl.

The vegetational changes and the future trend of succession on Cuttyhunk can also be considered in light of theoretical island biogeography. MacArthur and Wilson (1963) found that islands exhibit certain quantifiable patterns dependent upon an individual island's area, species diversity, and distance from the source of dispersing species. Islands that are far from source regions are less saturated with species than islands that are near. In fact, areas like Cuttyhunk may actually exhibit floristic impoverishment in terms of native species as compared with the mainland. This is a consequence of the poor dispersal ability of many native species over water barriers. Thus, far islands usually have fewer species than do similar sized islands nearer to the source region of dispersing species. Secondly, the species number decreases more on small islands, where the extinction rate is higher, than on large islands with increasing distance from the source. This latter prediction may partly account for the lower species diversity and higher extinction rate of species on Peninkese (Lauermann & Burk, 1976) in comparison to Cuttyhunk.

The species diversity of an island biota can be interpreted as an equilibrium between immigration and extinction (MacArthur & Wilson, 1967). In early successional stages, the rate of immigration exceeds the rate of extinction; however, the rate of immigration declines as rapidly dispersing species become established and fewer colonists are new to the flora. An equilibrium is eventually established between immigration and extinction. Penikese appears to have reached an equilibrium between immigration and extinction under the present ecological conditions (Burk & Lauermann, 1976); Cuttyhunk has still not reached a floristic equilibrium. On the other hand, over the past 50 years, immigration has markedly increased. Table 11 contains the total number of species, genera, and families for both the 1923 and 1974 floras. The total number of species has approximately doubled while the number of genera and families has

likewise increased substantially since the earlier flora. Table 12 shows the total flora at each collection period with invasions, extinctions, and persisting species since 1923. The number of persisting species slightly exceeds the number of extinctions, but the number of invasions is almost four times greater than the number of extinctions and more than twice the number of persisting species.

The Simpson Index of Resemblance (Simpson, 1956) has been used to calculate the degree of similarity and difference between the two floras. The value obtained is not influenced by species equitability. The Simpson Index is calculated by $100c/n_1$ in which c represents the number of taxonomic units common to the two floras and n_1 the total number of units in the smaller of the two floras. Table 13 contains the Simpson Index of Resemblance between 1923 and the 1974 floras of Cuttyhunk. Species composition has changed dramatically since 1923. A Simpson Index computed to compare the 1974 flora of Cuttyhunk and the 1973 flora of the neighboring island of Penikese emphasizes a difference between these two areas as well. Cuttyhunk is successionally more developed than Penikese even though Penikese appears to have reached a floristic equilibrium (Lauermann & Burk, 1976).

Table 13. The Simpson Index of Resemblance comparing the two major collections on Cuttyhunk, and the 1974 collection with the 1973 collection on Penikese.

Collection compared	Resemblance ($100^c/n_1$)
1923 and 1974	53.7
1974 Cuttyhunk flora and 1973 Penikese flora	67.6

The extinction rate on Cuttyhunk is further lowered as a consequence of larger island area, which permits the establishment of larger founding populations than can be established on Penikese. MacArthur and Wilson (1967) state that habitat diversity, and not area alone, is the ultimate regulator of species diversity. Area can be correlated with environmental diversity so that in combination these two variables can account for variation in species number. A larger island usually supports a larger flora because it is usually more environmentally complex than a smaller island at an equal distance from source regions. As a corollary, the predicted rate of extinction is lower on larger islands since population densities there are usually

higher. Again this appears to be the situation on Cuttyhunk and Penikese. Cuttyhunk has greater vegetational complexity than Penikese, certainly indicating the important role of habitat diversity in the control of floristic diversity. Perhaps for these reasons Cuttyhunk can support a more diverse flora with greater structural complexity than its less elevated, smaller neighbor Penikese.

THE 1974 FLORA

The following list contains 192 species new to the flora of Cuttyhunk collected during the present study. Nomenclature is based on Fernald (1950), Bailey (1924) for several cultivated species, and Hodgdon and Steele (1966) for *Rubus* subgenus *Eubatus*. Species that have become extinct since the 1923 flora are listed in Appendix I. The order of both lists follows Fernald (1950) for families, with genera within families and species within genera treated alphabetically.

In addition to the 264 species in the total flora number, five specimens representing distinct taxa were collected in unidentifiable condition. Three of these species are believed to be species of *Ranunculus*, *Rubus*, and *Vicia*. All specimens collected in this investigation have been deposited in the herbarium of Smith College (SCHN).

EQUISETACEAE

Equisetum arvense L. rare near Pond 10

LYCOPODIACEAE

Lycopodium inundatum L. rare near Pond 10

OSMUNDACEAE

Osmunda regalis L. rare in swampy lowlands

POLYPODIACEAE

Dryopteris noveboracensis (L.) Gray common in swampy thickets and pond margins

Onoclea sensibilis L. common in moist hollows and shady thickets, especially in southwest section

PINACEAE

Juniperus communis L. single specimen above the sandpit

J. virginiana L. single specimen on Copicut Neck

Picea glauca (Moench) Voss. cultivated in Gosnold

Pinus resinosa L. cultivated in Gosnold

P. sylvestris L. cultivated in Gosnold

TYPHACEAE

Typha latifolia L. common around Ponds 6, 7, 10, and 11

SPARGANIACEAE

Sparganium americanum Nutt. common emergent in ponds
S. eurycarpum Engelm. uncommon in ponds on Copicut Neck

ZOSTERACEAE

Zostera marina L. abundant along drift line

GRAMINEAE

Agrostis stolonifera L. abundant throughout grasslands in July and August
A. tenuis Sibth. abundant in grasslands in late June
Ammophila breviligulata Fern. abundant on sandy beaches, especially on Canapitsit Neck and Copicut Beach
Andropogon scoparius Michx. uncommon in grasslands on southwest side of island
Anthoxanthum odoratum L. abundant in grasslands
Danthonia spicata (L.) Beauv. fairly common in grasslands on southwest side
Dactylis glomerata L. abundant in grasslands in late June and early July
Digitaria sanguinalis (L.) Scop. uncommon is disturbed area
Distichlis spicata (L.) Greene locally common in salt marsh near Pond 16
Echinochloa crusgalli (L.) Beauv. locally abundant in marsh (Pond 18) on Canapitsit Neck
Elymus virginicus L. locally common Copicut Neck near ponds at eastern end
Eragrostis spectabilis (Pursh) Steud. uncommon along roadside on Copicut Neck
Festuca rubra L. uncommon in grasslands
Glyceria obtusa (Muhl.) Trin. uncommon in swamp near Pond 4 behind dump
Holcus lanatus L. common throughout grasslands
Lolium perenne L. (det. by H. Ahles) occasional
Panicum commutatum Schultes occasional along roadsides
P. clandestinum L. occasional along roadsides
P. dichotomiflorum Michx. locally abundant in muddy and sandy pond bottoms
P. oliganthes Schultes uncommon along unimproved roads
P. virgatum L. most abundant grassland species throughout by late summer
Phragmites australis Trin. locally abundant in marsh on Canapitsit Peninsula, near beach on Copicut Neck, and in Pond 6
Poa annua L. uncommon in grasslands
P. compressa L. uncommon in grasslands
P. pratensis L. uncommon in grasslands
Spartina alterniflora Loisel. abundant in salt marshes
S. patens (Ait.) Muhl. abundant in salt marshes and border of brackish pond

CYPERACEAE

Carex pennsylvanica Lam. uncommon
C. rosea Schkuhr uncommon
Cyperus diandrus Torr. abundant in moist muddy and sandy pond bottoms in association with *Panicum dichotomiflorum*
C. odoratus L. locally common around ponds
Eleocharis obtusa (Willd.) Schultes abundant emergent of pond borders throughout
Scirpus cyperinus (L.) Kurth. uncommon around ponds

COMMELINACEAE

Commelina communis L. single specimen on edge of "Bay View Road"

JUNCACEAE

Juncus acuminatus Michx. abundant around Ponds
J. canadensis J. Gay abundant in salt marshes and brackish areas
J. greenei Oakes & Tuckerm. common throughout
J. pelocarpus May. (det. by H. Ahles) common in sandy pond marshes and marsh
J. tenuis Willd. abundant in open soils, road edges, hillsides throughout

PONTEDERIACEAE

Pontederia cordata L. locally abundant in Pond 1

LILIACEAE

Maianthemum canadense Desf. rare in marsh around Sheep Pond (Pond 9)
Smilax rotundifolia L. uncommon in shrub layer

AMARYLLIDACEAE

Hypoxis hirsuta (L.) Civille uncommon in grasses between shrubby thickets on western half of the island

IRIDACEAE

Iris versicolor L. fairly common in swamps and pond borders

SALICACEAE

Salix babylonica L. single specimen next to dump, also cultivated in Gosnold
S. discolor L. rare in shrub community

MYRICACEAE

Myrica pensylvanica Loisel abundant throughout in hollows and on hillsides

POLYGONACEAE

Polygonum aviculare L. common in road edges around Gosnold
P. glaucum Nutt. restricted to sandy-cobble beaches
P. pensylvanicum L. border of Pond 1 and in field adjacent to Pond 5
P. persicaria L. common around ponds
P. punctatum Ell. abundant in swamps and around ponds
P. puritanorum Fern. abundant in swamps and around ponds
P. scandens L. rare in Pond 12 and on cobble shore of Gosnold Pond (Pond 8)
Rumex crispus L. abundant in sandy waste area near Gosnold Marina
R. maritimus L. rare on Canapitsit Neck
Rumex sp. probably *obtusifolius* L. (det. by H. Ahles)

CHENOPODIACEAE

Chenopodium album L. abundant drift line plant on Cuttyhunk Pond (Pond 17)
Salicornia bigelovii Torr. locally common in tidal pond (Pond 16) on cobble north shore of Copicut Neck

Suaeda maritima (L.) Dumort. abundant drift line species along sandy border of Cuttyhunk Pond (Pond 17)

PHYTOLACCACEAE

Phytolacca americana L. uncommon in tension zones

AIZOACEAE

Mollugo verticillata L. uncommon along road edges

CARYOPHYLLACEAE

Sagina procumbens L. (det. by H. Ahles) locally abundant on sandy border of Gosnold Pond (Pond 8)

Saponaria officinalis L. restricted to field near Bosworth House

Stellaria graminea L. uncommon

RANUNCULACEAE

Ranunculus bulbosus L. common in grasslands and in unimproved roads

R. cymbalaria Pursh. locally abundant on borders of Gosnold Pond (Pond 8) and Cattail Pond (Pond 11)

BERBERIDACEAE

Berberis thunbergii D.C. a garden escape along roadsides in shrubby thickets

LARDIZABALACEAE

Akebia quinata Decne. a garden escape along roadside in Gosnold

PAPAVERACEAE

Glaucium flavum Crantz. common on beaches

CRUCIFERAE

Barbarea verna (Mill.) Ashers. uncommon at town dump

Capsella bursa-pastoris (L.) Medic. rare near Gosnold Marina in waste area

Raphanus raphanistrum L. uncommon on Canapitsit Neck in waste areas and around foundation of the Old Boat House

Rorippa islandica (Oeder) Borbas uncommon at town dump

Sisymbrium officinale (L.) Scop. var. *leiocarpum* D.C. (det by H. Ahles)

DROSERACEAE

Drosera rotundifolia L. a single colony in clearing next to Pond 10

ROSACEAE

Geum canadense Jacq. uncommon in wet lowlands

Potentilla egedei Wormsk. (det. by H. Ahles) rare in marsh around Sheep Pond (Pond 9)

Prunus serotina Ehrh. uncommon on western side of island

Pyrus floribunda Lindl. (det. by H. Ahles) uncommon in swamp along road to West End

P. communis L. cultivated species along the main street, "Broadway"
P. malus L. in abandoned orchards on Copicut Neck and on main island
P. prunifolia Willd. in abandoned orchards on Copicut Neck
Rosa sp. probably *wichuriana* Crépin. (det. by H. Ahles) a garden escape forming a shrubby thicket at the "Crossroads"
Rubus allegheniensis Porter. uncommon in grasslands
R. arenicola Blanch. fairly common in open fields and hillsides
R. bifrons Vest. (det. by H. Ahles) locally abundant in patches on Copicut Neck and elsewhere in shrub community
R. flagellaris Willd. abundant in open grasslands throughout
R. jaysmithii Bailey common in grasslands

LEGUMINOSAE

Melilotus alba Desr. a single specimen observed in road edge near Gosnold Marina
M. officinalis (L.) Lam. a single specimen observed in field behind the Allen House
Robinia hispida L. in shrub community near sandpit and on Copicut Neck
R. pseudo-acacia L. cultivated species in Gosnold
Trifolium pratense L. common in fields, roadsides, lawns, and waste areas at the eastern end of the island

OXALIDACEAE

Oxalis europaea Jord. roadsides, waste areas, and in pavement cracks of Gosnold streets
O. stricta L. along road to West End and waste areas in Gosnold

POLYGALACEAE

Polygala polygama Walt. uncommon in open sandy areas

EUPHORBIACEAE

Euphorbia polygonifolia L. common on sandy-cobbly beaches above high tide mark

ANACARDIACEAE

Rhus copallina L. common in dense thickets throughout with *R. typhina*
R. typhina L. one of the most abundant species in dense thickets and copses throughout
Toxicodendron radicans (L.) Gillis common in grasslands

AQUIFOLIACEAE

Ilex laevigata (Pursh) Gray rare in shrub layer
I. verticillata (L.) Gray rare on Copicut Neck

ACERACEAE

Acer pseudo-platanus L. a cultivated species near the Bosworth House Inn in Gosnold
A. rubrum L. small population around "Paint Shack" near two planted trees

VITACEAE

Parthenocissus tricuspidata (Sieb. & Zucc.) Planch. along "Broadway" growing on stone fences

P. quinquefolia (L.) Planch. uncommon in shrub layer

Vitis labrusca L. in patch along road edge near the "Crosroads" and locally abundant in patch near sandpit on southwest side of the island

MALVACEAE

Hibiscus moscheutos L. locally abundant on Copicut Neck in Pond 12 and in marsh at eastern end; also planted on border of Pond 3

GUTTIFERAE

Hypericum boreale (Britt.) Brickn. common around ponds

H. canadense L. found only at sandpit

H. gentianoides (L.) BSP. limited in distribution to sandpit

H. mutilum L. uncommon around ponds

H. virginicum L. most abundant species of this genus around ponds

VIOLACEAE

Viola lanceolata L. uncommon in border of Pond 1

V. papilionacea Pursh garden escape near the Allen House

LYTHRACEAE

Decodon verticillatus (L.) Ell. common in swamps, pond borders, and moist hollows throughout

ONAGRACEAE

Epilobium glandulosum Lehm. collected only from damp thicket behind town dump near Pond 4

Oenothera biennis L. uncommon along roadside on Canapitsit Neck and around foundation of Old Boat House

UMBELLIFERAE

Hydrocotyle umbellata L. collected only from Pond 1 in shallow water

Ptiliminium capillaceum (Michx.) Raf. rare on border of brackish Pond 11 on Copicut Neck

ERICACEAE

Vaccinium corymbosum L. uncommon in shrub layer

PLUMBAGINACEAE

Limonium nashii Small (det. by H. Ahles) locally abundant in salt marsh on Cuttyhunk Pond (Pond 17)

OLEACEAE

Ligustrum vulgare L. garden escape into shrub community along roadsides in Gosnold, in central grasslands, and on cobble north shore of Copicut Neck

Syringa vulgaris L. garden escape into shrub community

ASCLEPIADACEAE

Asclepias syriaca L. (det. by H. Ahles) common only on road edges in Gosnold, especially at the "Crossroads"

CONVOLVULACEAE

Convolvulus sepium L. occasional in grassy road edges

LABIATAE

Glechoma hederacea L. occasional on pond borders

Lycopus rubellus Moench common along southwest side of the island including the town dump and sandpit, and on the brackish borders of ponds on Copicut Neck

Nepeta cataria L. restricted to cobble shore of Sheep Pond (Pond 9)

Prunella vulgaris L. uncommon on grassy borders of ponds

Teucrium canadense L. abundant throughout in moist thicket, swamps, pond borders, and in cobble shore on Copicut Neck

Trichostema dichotomiflorum L. locally abundant at sandpit only

SOLANACEAE

Datura stramonium L. rare in disturbed area near residence

Petunia hybrida Viln. uncommon garden escape in road edge on Canapitsit Neck

Solanum dulcamara L. common along roads in Gosnold

S. americanum Mill (det. by H. Ahles) uncommon in cobble border of Gosnold Pond, and along edge of unimproved road to the West End

SCROPHULARIACEAE

Gratiola aurea Muhl. locally abundant on bottom of Pond 3

Linaria vulgaris Hill. uncommon in field near the Allen House Inn

Lindernia anagallidea (Michx.) Pennell uncommon on shore of Copicut Neck

Verbascum thapsus L. locally abundant at town dump and on Copicut Isthmus

BIGNONIACEAE

Catalpa bignonioides Walt. single cultivated specimen on southeast side

PLANTAGINACEAE

Plantago major L. common in waste areas and road edges

RUBIACEAE

Cephalanthus occidentalis L. locally abundant in swamp on Copicut Neck

Galium tinctorium L. (det. by H. Ahles) common in marshes and pond borders

CAPRIFOLIACEAE

Lonicera japonica Thunb. abundant in thickets, woodland edges, and roadsides throughout

Viburnum dentatum L. common in shrub layer throughout

COMPOSITAE

Ambrosia artemisiifolia L. common in waste areas and road edges especially in Gosnold

A. psilostachya DC. var. *coronopifolia* (T. & G.) Farw. (det. by H. Ahles) rare in waste area near marina
Arctium minus (Hill) Bernh. locally abundant at town dump
Aster pilosus Willd. (det. by H. Ahles) rare in road edge near Fisherman's Pier
A. ericoides L. (det. by H. Ahles) uncommon in pavement of "Road to the Lookout" near the library
Bidens tripartita L. (det. by H. Ahles) occasional
Chrysanthemum leucanthemum L. locally abundant on Copicut Isthmus and at town dump
Chrysopsis falcata (Pursh) Ell. uncommon along road to the West End
Cichorium intybus L. abundant in coastal waste areas and road edges in Gosnold
Cirsium arvense (L.) Scop. common in grasslands and grassy road edges
C. discolor (Muhl.) Spreng rare on north shore of Copicut Neck
C. horidulum Michx. rare on sandy border of Gosnold Pond (Pond 8)
C. muticum Michx. common in grasslands
C. pumilum (Nutt.) Spreng. (det. by H. Ahles) common in grasslands
Erechtites hieracifolia (L.) Raf. abundant drift line plant on sandy border of Cuttyhunk Pond (Pond 17); also common in coastal waste areas and at dump
Erigeron canadensis L. abundant in coastal waste areas especially near the Coast Guard Station on Canapitsit Neck
E. annuus (L.) Pers. (det. by H. Ahles) rare in road edge in Gosnold
E. pusillus Nutt. common in coastal waste areas near Gosnold
E. strigosus Muhl. rare in tension zone on Canapitsit Neck
Gnaphalium obtusifolium L. common in sandy tension zones on Canapitsit Neck and Copicut Beach
G. uliginosum L. tension zone on Canapitsit Neck
Hieracium florentinum All. uncommon along unimproved roads
Hypochoeris radicata L. uncommon along unimproved roads
Leontodon autumnalis L. uncommon along unimproved roads
Matricaria matricarioides (Less.) Porter (det. by H. Ahles) common
Pluchea purpurascens (Sw.) DC. uncommon in field adjacent to Pond 5 only
Solidago nemoralis Ait. uncommon along inland road edge
S. tenuifolia Pursh. abundant in grasslands and along road edges throughout
Sonchus asper (L.) Hill. uncommon on sandy and cobbly beach beyond high tide line on Canapitsit Neck
Taraxacum officinale Weber. uncommon along unimproved roads and grasslands
Xanthium echinatum Murr. common on Copicut Isthmus only

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APPENDIX I

Vascular plant species of the 1923 flora of Cuttyhunk Island collected by Fogg (Fogg, 1930) not collected during the present study.

POLYPODIACEAE

Athyrium felix-femina (L.) Roth
Dennstaeditia punctilobula (Michx.) Moore

OPHIOGLOSSACEAE

Ophioglossum vulgatum L.

ZOSTERACEAE

Potamogeton perfoliatus L. var. *bupleuroides* (Fern.) Farw.
Ruppia maritima L. var. *longipes* Hagstrom

HYDROCHARITACEAE

Vallisneria americana Michx.

GRAMINEAE

Calamagrostis canadensis (Michx.) Beauv.
Paspalum ciliatifolium var. *muhlenbergii* (Nash) Fern.
Puccinella paupercula (Holm) Fern. & Weatherby
P. fasciculata (Torr) Bickn.
Spartina pectinata Link.

CYPERACEAE

Carex debilis Michx. var. Rudgei Bailey
C. hormathodes Fern.
C. howei Mackwnzie
C. laevivaginata (Kubert) Mack.

C. limosa L.
C. lupulina Muhl.
C. silicea Olney
C. spicata Huds.
C. swanii (Fern.) Mack.
Cladium mariscoides (Muhl.) Torr.
Eleocharis uniglumis (Link.) Schultes
Eriophyllum tenellum Nutt.
E. virginicum L.
Rhynchospora alba (L.) Vahl.
Scirpus validus vahl.

ARACEAE

Acorus calamus L.

JUNCACEAE

Juncus articulatus L. var. *obtusatus* Engelm.
J. dichotomus Ell. var. *platyphyllus* Wiegand

IRIDACEAE

Sisyrinchium graminoides Bicknell

ORCHIDACEAE

Habenaria clavellata (Michx.) Spreng.
H. lacera (Michx.) Lodd.

URTICACEAE

Boehmeria cylindrica (L.) S.W. var. *drummondiana* Wedd.

CRUCIFERAE

Nasturtium oficinale R. Br.

LEGUMINOSAE

Vicia villosa Roth.

LINACEAE

Linum striatum Walt.

POLYGALACEAE

Polygala cruciata L.

ELATINACEAE

Elatine minima (Nutt.) F. & M.

VIOLACEAE

Viola fimbriatula Sm.

MELASTOMALEAE

Rhexia virginica L.

ONAGRACEAE

Epilobium palustre L. var. *monticola* Hausch.

UMBELLIFERAE

Sium suave Walt.

ERICACEAE

Rhododendron viscosum (L.) Torr.
Vaccinium macrocarpon Ait.

PRIMULACEAE

Lysimachia terrestris (L.) BSP.

GENTIANACEAE

Bartonia virginica (L.) BSP.
Menyanthes trifoliata L. var. *minor* Michx.

LABIATAE

Mentha crispa L.

SCROPHULARIACEAE

Veronica peregrina L.

PLANTAGINACEAE

Plantago aristata Michx.

COMPOSITAE

Anaphalis margaritaceae (L.) B. & H.
Antennaria neglecta Greene
Aster multiflorus L.
Solidago stricta Ait.

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